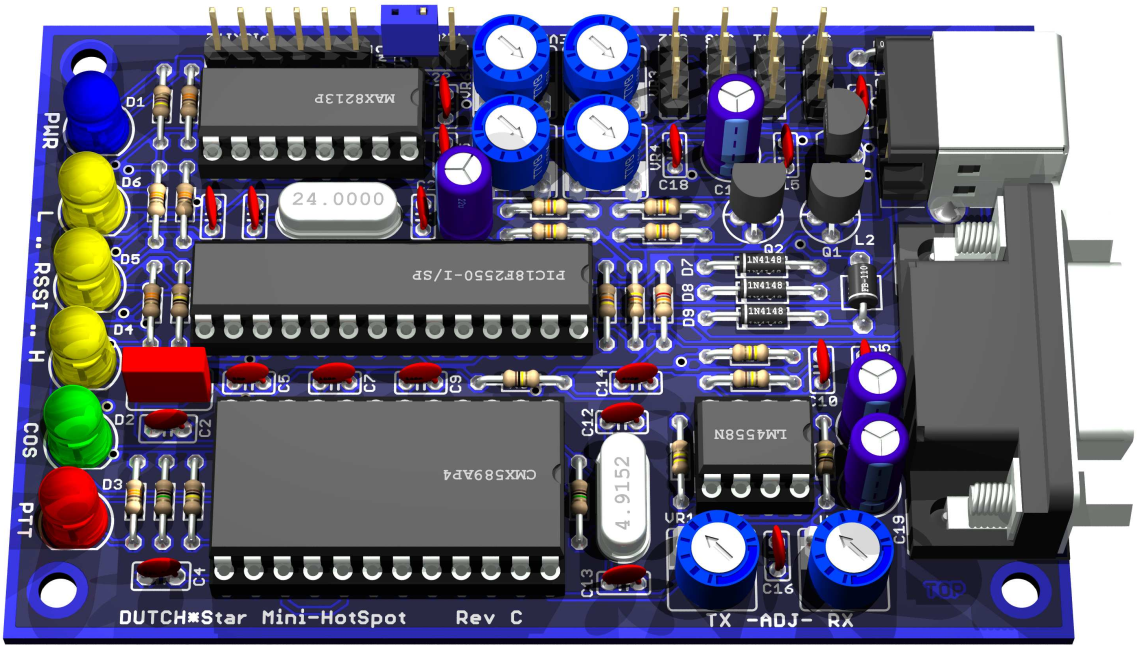
DUTCH*Star "Mini-Hotspot" Series



Construction and Reference Manual

Version 2.00

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D-STAR, For The Rest Of Us !

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1. Introduction

Welcome to the exciting world of Digital Voice Communications for Amateur Radio!

D-STAR (Digital Smart Technologies for Amateur Radio) is a communications system for Amateur Radio operators where the voice audio is transmitted as a digital signal rather than as analog audio.

Operators use standard VHF/UHF/SHF radio transceivers (handheld units, mobile radios, and so on), and their voice audio is converted to a digital data stream by those transceivers. The data is then transmitted on-air with the use of a GMSK-based modem that is (of course) built in to them. Most of these transceivers can also handle regular, analog (FM) based audio.

Although communications between these transceivers (in Simplex mode) to provide noise-free digital communications between the operators is of course possible, the real power of this mode of operation is unleashed by using a repeater system. The repeater extends the range of these transceivers considerably, but, being a digital (data-based) system, it is extremely easy to connect multiple repeaters into a network of repeaters, using RF links, the Internet, or both.

One of the most criticised aspects of the D-STAR system, however, is that there is only one global commercial manufacturer of radio equipment for it.

We are now seeing a series of software projects and hardware developments that bring the fun (and power) of D-STAR to the home brewer, however. Software projects allow you to connect your PC to the D-STAR network, and listen to the conversations that take place there. Various hardware projects have resulted in products that you can build (or assemble) yourself, and with them you can convert your PC into an almost-real D-STAR repeater, for example.

The DUTCH*Star "*Mini-Hotspot*" series of boards is an example of such products.

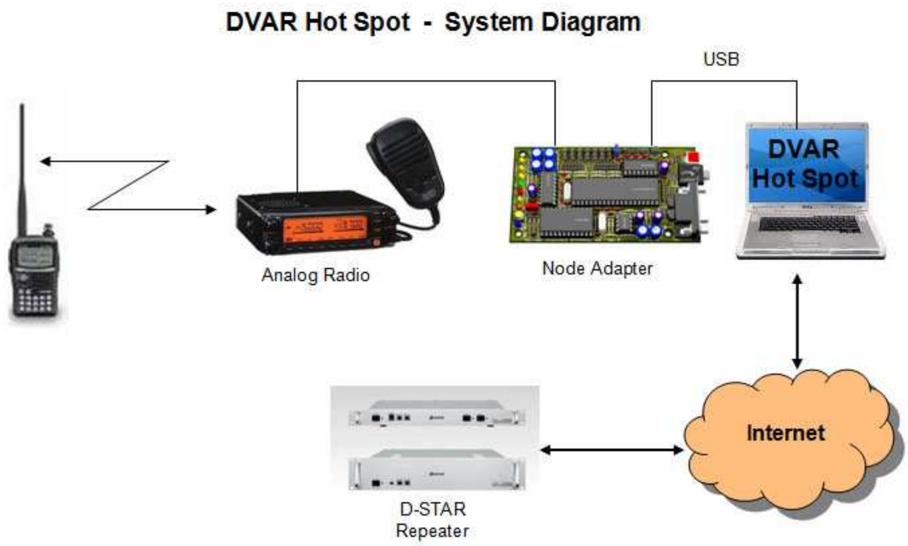
Initially intended to be used as a simplex-mode repeater for in and around the house (allowing you to use your handheld at its lowest RF power setting, which greatly extends its battery life of course) recent advancements in both device firmware as well as in PC application development have effectively turned the board into a full-feature repeater system, with or without the assistance of a PC-based gateway to the Internet.

Once you finish building one (either using your own parts, or by assembling the 'parts kit' you purchased from us) you will be able to connect it to a PC, configure it, and then set it up as a full-featured repeater for D-STAR users in your area, costing a *lot* less than a comparable setup using commercial products!

In its standalone mode of operation, the on-board firmware (the piece of software that is loaded into the board's microprocessor memory, and which controls all of its functions) only requires an external computer during its configuration.

Once configured, the external computer can be disconnected, and the board will perform its programmed function(s) completely on its own.

For example, if you configured it to act as your local HAM club's D-STAR repeater, it will happily do so: in this scenario it is equivalent to the controller seen in most analog repeater systems, where the controller sits between a receiver radio and a transmitter radio and then controls whether or not a transmission received will be forwarded to the transmitter.



In its **simplex** mode of operation (which is how most people use it) only a **single radio is connected** to it, and the board will switch modes (receive / transmit) as needed.

Obviously, in this mode, the presence of an external computer running some sort of D-STAR gateway application is required; the system will then forward (transmit onto RF) the data coming in from the gateway connection, and, also, it will forward to that gateway connection any data it has received on its RF port.

If you later decide you'd rather have a duplex system

Now… get your tools out, and have fun building!

2. Construction Notes

2.1 General

Construction of your DUTCH*Star PCB Kit is easy, but, like all electronics assembly tasks, it does require some attention. We won't bother you with the usual warnings about soldering irons being **hot** and **lead** being **poisonous if swallowed**, as we all know that, right?

Each PCB has a clear-white printing showing where the various parts go, what their names are, and, if applicable, what their polarity or orientation is. An enlarged copy of them can be found at the end of this document in **Appendix A: Parts Placement**, by the way. Many builders prefer to have a printed copy of that in front of them during the construction process.

In general, all components should be placed in a logical order. To avoid not being able to reach a certain spot, most people seem to prefer doing the small, flat components (resistors, diodes, small capacitors) first, and then move upwards in height.

Place the **crystals** flat onto the PCB, and **cut their leads as short as possible**. Transistors should also be placed as close onto the PCB as possible, a space of 3mm is enough.

Be careful when soldering the LEDs: notice the orientation of the flat side of the LED, and keep in mind that if you want to bend the leads into a 90-degree angle, it looks better if you do this **before** soldering them in.

It looks better, and, in some cases, gives better results if the leads of the components are cut 'flush' at the bottom side of the PCB, meaning, cut them off as short as possible. This avoids ugly bumps sticking out. This can be done easily with any good flat-head cutting tool.

Finally: don't be afraid to 'melt' a component. Most modern electronics components can deal with a lot of heat. When soldering a pin, allow the solder time to properly melt, flow around the pin, into (and through) the hole. In many cases where a board did not work, it was found that pins had not been soldered properly, the solder had not flowed out and so the connection was not good. **Let it flow!**

2.2 Board Corrections

If errors were found after production of the PCB, we list them in this manual, including tips on how to fix things on your board. See **Appendix C: Corrections** for notes and instructions specific to the revision of the board you have.

> Please take note of these issues ***BEFORE*** doing any soldering; if you have to "fix" these errors after completing assembly of the board, you may damage the board beyond repairs!

You can also check the website if any new updates were issued since the writing of this revision of the manual.

2.3 Assembly

Actual assembly of the kit is best done in a series of steps, the first step being inspection of all the parts in the kit. Spread out the parts on a flat, clean surface (preferably a white-coloured kitchen table, although family members do not always appreciate such use of house tables) and sort them into the various groups of components (resistors, capacitors and so on.) Where applicable, sort them again based on value.

Now, compare the parts you have with the appropriate table in **Appendix B: Parts Lists**.

> Please contact your kit supplier ***BEFORE*** doing any soldering if you seem to have an incomplete kit. Errors during the creation of the kits do happen, but we can only "fix" them if we're notified of them!

Now, assuming your kit is complete, we can begin!

- Work from small (and flat) components to big and tall ones: first all the resistors, then the diodes, ferrite bead and then the small 2.5mm capacitors. Although electrically not important, it **does** look nice if you place all resistors in the same direction (with respect to their "tolerance" ring.)

Inspect the PCB for soldering errors, and clean up where needed.

- Now place the crystals (be careful not to drop them, many crystals can be damaged if they are subjected to such a shock, it will cause their frequencies to be changed!), the transistors and the 78L05 voltage regulator – **this one looks like one of the transistors**, but isn't one of them!

Re-check the PCB, and measure the resistance between the GND and VCC lines, this should be high impedance.

- Place the IC sockets, the elco's and the LED's.

- Place the various (DB9, USB etc) connectors.

- Lastly, cut the supplied pin-header strip to the sizes needed (see the list in **Appendix B: Parts Lists**) and sort them based on the number of pins. Solder them onto the PCB, and beware that many people find it hard to make them stand up straight. It can be done, really, but it does take some concentration to get them lined up nicely.

- Place the supplied jumpers on them in the 1-2 positions. The **RED jumper** is intended for the **Power Select** header. If your kit comes with one, use the **BLUE jumper** for the **PROG header** (the 2-pin header next to the 6-pin programming connector.) Also, use a small screwdriver to tune all trimpots in their middle positions. We will re-tune them later.

After all components have been soldered onto the PCB, perform a careful inspection of the PCB, especially its soldering side. It often is a good idea to clean the PCB with a flux-removing substance such as Deflux, or simply using alcohol. Flux can, in some cases, cause really-hard-to-find problems, so the more you can remove, the better the results will be.

If available, you could now connect a DC power source to the board, and the blue (PWR) LED should light up. You could also measure for correct voltages on the various IC pins to make sure "all is well". To do this, the "power select" jumper (see **Appendix D: Jumper Settings**) must be placed, and properly set, as otherwise the board will not receive any power!

Connect the PCB to the USB port, and, again, measure voltages on the IC socket pins to make sure you don't have any surprises there.

When all seems good, insert the IC's into their sockets and hope for the best while powering up the board again…

3. Hardware Setup

3.1 Radio Connector and Cabling

To make use of the board, you must have available one (or two, see below) radios capable of doing high-speed data. Most modern transceivers (those less than, say, 10 years old) **support 'data' (also known as 'packet') modes at 9600bps**. Quite often, these radios have a special connector (port) for this mode (standard seems to be a 6-pin Mini-DIN plug, but 13-pin DIN plugs are seen as well.) The radio usually can be configured to enable these ports for use through their configuration software or menu system.

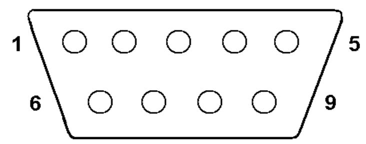
In other cases, radios can be modified for this purpose by adding a direct connection to their receiver discriminator and transmitter modulator circuits.

3.1.1 D-SUB9 Radio Connector

All connections from and to the attached radio(s) are through a single 9-pin D-SUB connector. Although smaller connector types exist, experimentation has shown that most test users preferred this connector over the smaller ones.

The pin-out of the D-SUB connector on the board is as follows:

1	Radio **MIC** (audio input TO radio)
2	Radio **COS** (squelch)
3	Radio **SPK** (audio output FROM radio)
4	Radio **PTT**
5	**GND**
6	
7	
8	
9	**DC** Power Input (optional, 20V max)

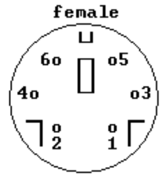


This is the connector when **seen from the outside**, so, when looking at the connector's pins. It is also the soldering side of the female connector that mates with it, the one which you will use to create a cable for your radio.

3.1.2 Mini-DIN 6-pin Radio Connector

Most, if not all of the modern Amateur Radio transceivers are equipped with a 'data port' (sometimes referred to as a 'packet port') to which a TNC (Terminal Node Controller) or some other form of modem can be connected. We can connect our board to the radio using this connector without problems.

The pinout for this connector seems to be standard on all transceivers:

1	Audio **IN** (audio to radio)	
2	**GND**	
3	Radio **PTT**	
4	Audio **OUT** (from radio, **9600bps**)	
5	Audio **OUT** (from radio, 1200bps)	
6	Radio **COS**/Squelch	

This is the connector when seen from the outside, so, when looking at the connector's holes. It is also the soldering side of the male connector that mates with it, the one which you will use to create a cable for your radio.

Please check the operator's manual of your radio to determine if you have to change any other settings before you can use this port. Some radios require the user to specifically enable it, for example. **Often, the radio has to be configured for either 1200bps (default) or 9600bps mode: for D-STAR GMSK, you then have to set it to 9600bps mode**. Finally, if the radio supports it, enable the **"Narrow FM" (2.5 kHz) mode** of operation, as this is what D-STAR was designed for.

3.2 Radio Interconnection Cable

Depending on the radio used, you should now acquire or make an interconnecting cable between the board and the radio(s). For a **single radio**, this is a straightforward task. In case of doubt, leave Pin9 (DC Power Input) unconnected and only connect it if you are sure the radio can supply the required power and its voltage will not exceed our limit.

A cable that will work for most radios with a MiniDIN-6 connector would be as follows:

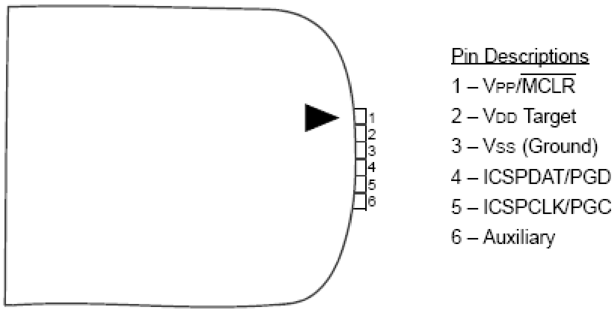
DSUB-9	Signal	MiniDIN-6
1	AUDIO_OUT	1
2	COS	6
3	AUDIO_IN	4
4	PTT	3
5	GND	2

If your configuration is set up for **duplex mode**, you will either have to connect it to a single radio which is capable of handling full-duplex communications (special repeater-mode radios) or you must connect two separate radios, one for RX (receive), and the other for TX (transmit.) Dual-radio operation will often require some sort of 'splitter' cable, where the single (female) DB9 end connects to our board, and the other end of the splitter has two (male) DB9's with each carrying only half the signals; the **RX connector has (2, 3, 5 and optionally 9)**, and the **TX connector then has (1, 4 and 5.)**

<u>**NOTE**</u>: It is recommended to **only "draw" power (if any) from the RX radio** in a dual-radio configuration.

3.3 PICkit2 Programming Connector and Cable

Under normal circumstances you should not need this connector, but in case you do, here is the (standard) pinout:



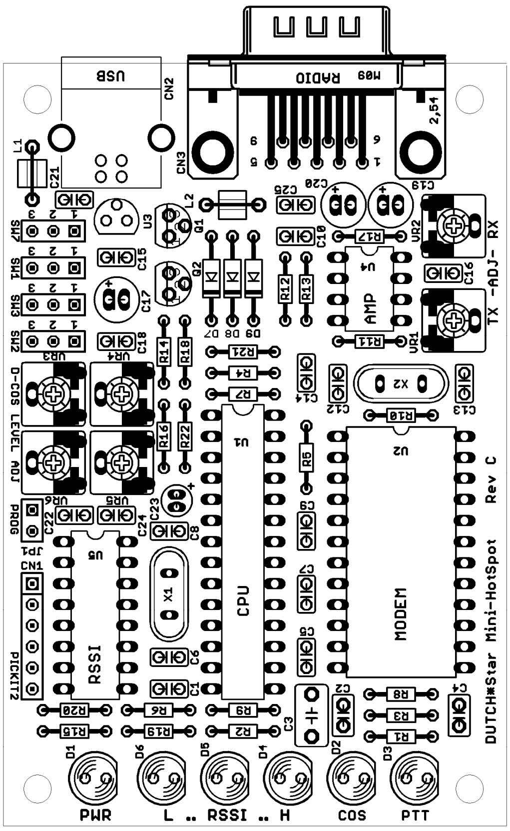
This connector is used to connect the board to a Microchip PICKIT2 programming device, used to upload new program code to the PIC chip. Most, if not all, DUTCH*Star-supplied PIC chips have been pre-programmed with a boot loader, which allows the user to perform this task through the USB port and the board's configuration application.

3.4 Setting the Jumpers

Refer to **Appendix D: Jumper Settings** for how to set the jumpers on your board.

Appendix A: PCB Parts Placement

Below is an enlarged version of the PCB to give you a better view of where the various parts are located. Make sure you are looking at the correct revision of the board; parts may have been changed around between revisions!



Appendix B: Parts List

Your kit should contain these items:

1	PinHeader 1x6	CN1		**5**	Resistor 330	R1,2,6,19,20
1	PCB Socket USB-B	CN2		**1**	Resistor 470	R15
1	PCB Socket DB9-M	CN3		**1**	Resistor 27K	R21
4	PinHeader 1x3	SW1,2,3,7		**6**	Resistor 47K	R4,7,14,16,18,22
1	PinHeader 1x2	JP1		**4**	Resistor 100K	R5,8,9,17
2	FerriteBead FB-110	L1,L2		**1**	Resistor 180K	R13
				2	Resistor 470K	R11,12
5	Capacitor 22p	C5,6,8,12,13		**2**	Resistor 1M	R3,10
1	Capacitor 330p	C10				
1	Capacitor 470p	C14		**1**	Trimpot 10K	VR6
2	Capacitor 22n	C2,4		**3**	Trimpot 100K	VR3,4,5
9	Capacitor 100n	C7,9,15,16,18, 21,22,24,25		**1**	Trimpot 500K	VR2
1	Capacitor 470n	C1		**1**	Trimpot 1M	VR1
1	Capacitor 1uF	C3				
1	Elco 10u	C20		**1**	LED 5mm BLUE	D1
1	Elco 22u	C23		**1**	LED 5mm GREEN	D2
2	Elco 47u	C17,19		**1**	LED 5mm RED	D3
				3	LED 5mm YELLOW	D4,5,6
1	IC PIC18F2550-I/SP	U1				
1	IC CMX589AP4	U2		**3**	Diode 1N4148	D7,8,9
1	IC 78L05Z	U3		**2**	Transistor BC547	Q1,2
1	IC LM1458N	U4				
1	IC MAX8213P	U5		**1**	XTAL 4mm 4.9152	X2
				1	XTAL 4mm 24.0000	X1
1	IC SOCKET28P-3	U1				
1	IC SOCKET24P-6	U2		**5**	JUMPER 2.54mm	SW1,2,3,7,JP1
1	IC SOCKET8P	U4				
1	IC SOCKET16P	U5		**1**	PCB Mini-HotSpot	Rev.C

Please note that depending on the availability of parts from manufacturers and suppliers, **equivalent replacements** may be substituted in your kit. These substitutes are fully equivalent to the parts mentioned above and/or in the schematics, even though their part numbers are not exactly the same.

Appendix C: Corrections

No changes so far.

Appendix D: Jumper Settings

Switch		1-2 function		2-3 function
SW1		COS signal fed into transistor for positive COS signals.		COS signal fed directly to PIC (negative COS signal.)
SW2		Select D-COS (Digital COS) mode		Select A-COS (Analog COS) mode
SW3		COS signal fed directly to PIC (negative COS signal.)		COS signal taken from transistor for positive COS signals.
SW7		Operating power is taken from the USB bus.		Operating power is taken from the radio connector, and the USB bus power is disconnected.
JP1		Select PROG/RESET mode.		

The **COS signal** of the radio can be negative (0V indicates a valid signal) or positive (a positive voltage indicates a valid signal), and the SW1 and SW3 switches must be set accordingly. Most radios provide a positive signal, which means **SW1** in the **1-2** position, and **SW3** in the **2-3** position.

In addition to this method (Analog COS, A-COS) of deciding when a valid signal is present, a new mode of COS operation (on the Rev. B or newer boards) is **Digital COS** (D-COS), which is a system where the quality of the data signal (as seen by the GMSK modem IC) is monitored, and compared to a pre-set threshold value; if the measured value is above the threshold, we assume a valid signal is present. On these boards, **SW2** is used to select between the two modes.

Operating power can be taken from either the USB bus, or from the radio itself. Since the board can be set to operate in Standalone Repeater mode (where no PC is present), this jumper allows you to power the board from the radio's DC supply instead. Setting **SW7** to the **1-2** position, selecting USB power mode, and the **2-3** position sets "external DC" mode.

The **PROG/RESET** jumper is only needed when using DUTCH*Star firmware. If this jumper is present when the board is reset (or powered up), it will make it enter the PROGRAM mode of the USB Boot Loader, which allows you to (forcibly) update the firmware of the board. This is normally only needed if the firmware has been corrupted and there is no other way of recovering from that.

NOTES